PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Tunable Wave-guide Detectors

We, DOUGLAS HAROLD TOMLIN, B.Sc., of Admiralty Signal Establishment, Lythe Hill House, Haslemere, Surrey, and CHARLES SEYMOUR WRIGHT, C.B., O.B.E., M.C., M.A., Director of Scientific Research, Admiralty, London, S.W.1, both of British Nationality, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is for improvements in or relating to tunable wave-guide detectors, particularly for use at centimetre wave-lengths, for the measurement of impedance, wave-length and loss in a rectangular wave-guide by measurement of H_{10} waves.

A tunable wave-guide detector, particularly for use at centimetre wave-lengths comprises, according to the invention, a thin probe wire having one end arranged so to project into a rectangular wave-guide under test as to pick up H_{10} waves and the other end extending axially through a fixed flat end of a cylindrical resonant cavity so as to excite the cavity in the E_0 mode, and a circular piston forming the second flat end of the cylindrical resonant cavity and movable axially therein, in combination with a detector coupled to a second thin probe wire movable with the circular piston and projecting therethrough into the cylindrical resonant cavity.

The main advantage of a detector according to the invention over known resonant cavity detectors is in the use of a particular mode of resonance which permits the coupling probes to be arranged in such a manner that each projects normally through one end of a cylindrical resonator. As one end of the resonator is fixed and the other end is formed by the face of a movable piston, the probe associated with the piston moves as the piston is adjusted for tuning purposes and, therefore, both coupling probes are always in the optimum positions. This arrangement provides greater sensitivity over a wider wave-length band than in detectors where the tuning pistons are adjustable independently of fixed coupling probes.

In the present arrangement there is only one sliding contact surface namely, that between the piston and the wall of the cylindrical resonant cavity and since no surface currents flow in the vicinity of the contact it is not necessary for a particularly good electrical contact to be made. Moreover, the arrangement according to the invention enables the detector to be so designed as to provide a rigid mechanical mounting on the wave-guide under measurement and to be of generally strong construction.

In order that the invention may be readily understood an example thereof will now be described with reference to the accompanying drawings in which:—

Figure 1 shows diagrammatically the position of a probe wire in relation to the rectangular wave-guide under test in order to detect H_{10} waves;

Figure 2 is a part sectional view of a tunable detector constructed according to the invention;

Figure 3 shows in detail a contact arrangement employed in Figure 2; and

Figures 4 and 5 indicate the method of mounting the detecting crystal in the arrangement illustrated in Figure 2.

As stated above it is desired to measure H_{10} waves in a rectangular wave-guide and a probe wire is therefore inserted in the wave-guide in a direction parallel to the **Y**-axis and enters it through a longitudinal slot cut in the wall of the guide in the plane $X=\frac{a}{2}$, as shown in Figure 1 where a is the length of the larger side of the rectangular wave-guide. Referring to Figure 2, a rectangular brass block is cut at one end as to form a bridge 1 for fitting over the rectangular wave-guide under test, not shown. The other end of the brass block is drilled so as to form a cylindrical cavity 2 separated from the wave-guide cavity 1 by a metal plate 3 of a thickness just sufficient to provide the necessary mechanical rigidity. A small diameter hole is bored through the centre of the metal plate 3

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and an exciting probe wire 4 is fixed therein so as to project into both the wave-guide space 1 and into the cylindrical cavity 2. The probe wire 4 is supported in a thin disc of insulating material screwed to the plate 3. The wave-guide is provided with a probing slot in known manner and the underside of the plate 3 is provided with a rectangular projection 5 along the centre thereof having a width and depth such that it fits into the wave-guide probing slot with the edge thereof level with the inner surface of the wave-guide. The object of this projection is to screen the probe wire 4 from the sides of the slot. A circular piston 6 is mounted within the cylindrical resonant cavity 2 and is adjustable along the axis of the cylinder so as to permit the cavity to be tuned. The piston 6 is attached to a circular tube 7 which is screw-threaded on the outer surface thereof and in conjunction with a correspondingly screw-threaded bush 8 enables the piston to be moved axially within the resonant cavity 2. A crystal or other suitable detector 9 is mounted within the tube 7 and is joined to a second probe wire 10 projecting axially through the piston into the resonant cavity. Good contact between the piston 6 and the walls of the resonant cavity 2 is obtained by the use of a hardened contact member 11 made of beryllium copper soldered around the circumference of the piston. One edge of the contact member 11 is provided with contact teeth, as shown in Figure 3, each of the teeth being dimpled so as to make close contact with the inner surface of the resonant cavity 2. The strip of metal forming the contact member 11 is bent into a ring around the circumference of the piston 6 and thereafter hardened and soldered into position so that the dimples on the teeth bear on to the wall of the cylinder under the spring action of the hardened beryllium copper.

The crystal 9 is mounted in a holder 12 shown in more detail in Figure 4 the holder being in the form of a brass tube which is a sliding fit in the circular tube 7. The crystal pin 13 fits into a small cup 14 soldered to the end of the crystal probe wire 10 which extends through a small hole drilled in a thin brass strip 15 soldered to the lower end of the holder 12, the brass strip 15 having such impedance at high-frequency that it does not form a short-circuit between the holder 12 and the cup 14. The crystal is connected so as to carry the rectified currents in the manner illustrated in Figure 5. A single cored screened lead 16 is connected to two brass discs 17 and 18 separated by a mica disc 19, the inner core being soldered to the lower brass disc 18 and the outer sheath being soldered to the upper brass disc 17 and the discs being so dimensioned that they fit into the crystal holder 12. The upper part of the holder 12 is internally screw-threaded and a screw having a small axial hole therein to accommodate the screened lead 16 is fitted therein so that when screwed down on top of the brass disc 17 it presses the lower disc 18 into contact with the head of the crystal 9 the latter being insulated from the holder 12 by an ebonite washer 20 and the lower brass disc 18 being insulated from the holder 12 by a small air gap. Thus the two brass discs 17 and 18 separated by the mica disc 19 form a condenser which provides a low impedance path for any high-frequency currents not completely rectified by the crystal; and the brass strip 15, which connects the crystal pin 13 with the holder 12, provides a return path for the rectified current.

The underside of the wave-guide space 1 is provided with four spring-loaded ball bearings, two of which are shown in Figure 2, for providing a convenient sliding bearing for the wave-guide under test.

In operation, the cavity 2 resonates at a wave-length λ when the piston 6 is adjusted to limit the length of the cylinder to $\frac{n\lambda}{2}$, when n is a positive integer. It is thus possible to tune the cavity to wave-lengths in at least two different ranges. In one range, corresponding to $n=1$, the cavity resonates at a wave-length $\frac{\lambda}{2}$ and in a second range, where $n=2$, at a wave-length, λ.

In addition to the tuning adjustsment effected by the movement of the piston 6, the crystal holder 12 is free to slide within the circular tube 7 so that the effective length of the crystal probe wire 10 is also variable and in this manner the degree of coupling between the resonant cavity 2 and the crystal 9 could be controlled. In practice, it is found that this adjustment assists the tuning of the cavity 2 and is useful as a preliminary setting before the tuning is finally adjusted by means of the piston 6, optimum response being obtained by alternately adjusting the degree of coupling and the position of the piston 6.

The exciting probe wire 4 is not adjustable in length and is preset by experiment to give maximum response at the centre of the wave-length band to be

employed a different length being required if the range were changed from half-wave to full-wave resonance as stated above. Generally however, the length of probe wire 4 projecting into the resonant cavity 2 should be about $\frac{\lambda}{8}$ but the variation of its length as the wave-length is varied over a reasonable band will be quite small.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A tunable wave-guide detector, particularly for use at centimetre wave-lengths, comprising a thin probe wire having one end arranged so to project into a rectangular wave-guide under test as to pick up H_{10} waves and the other end extending axially through a fixed flat end of a cylindrical resonant cavity so as to excite the cavity in the E_0 mode, and a circular piston forming the second flat end of the cylindrical resonant cavity and movable axially therein, in combination with a detector coupled to a second thin probe wire movable with the circular piston and projecting therethrough into the cylindrical resonant cavity.

2. A tunable wave-guide detector constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 21st day of February, 1945.

F. FIDLAN,
Acting for the Applicants.

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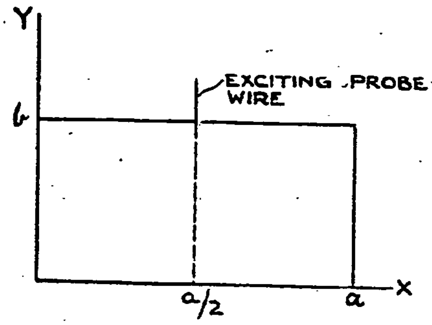


FIG. 1

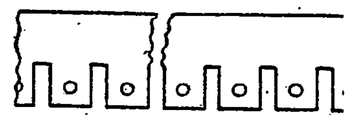


FIG. 3

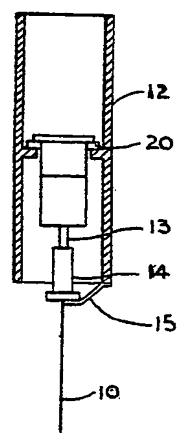


FIG. 4

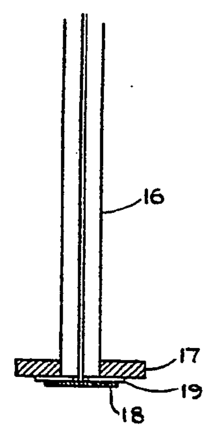
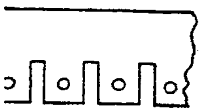


FIG. 5



G. 3

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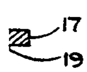

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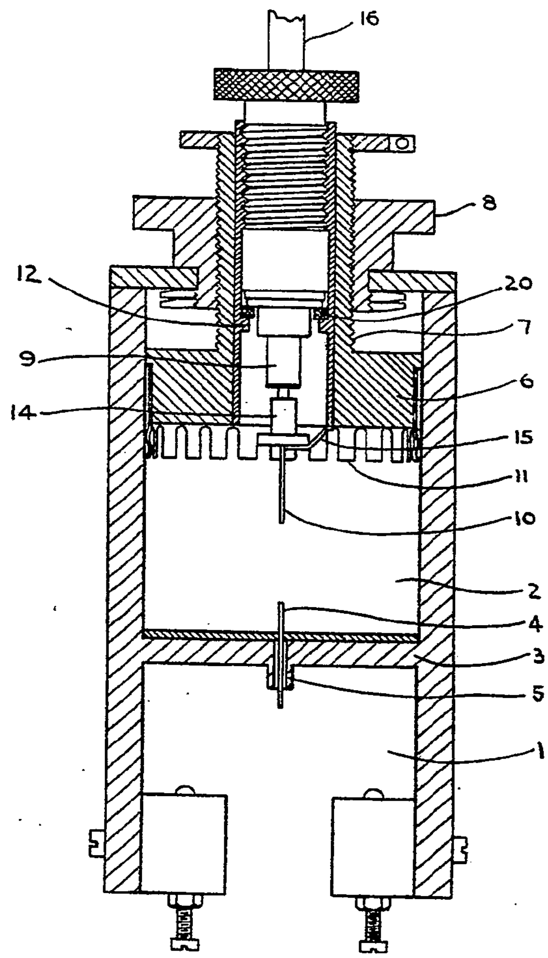

FIG. 2.

H.M.S.O. (Ty. P.)

[This Drawing is a reproduction of the Original on a reduced scale]

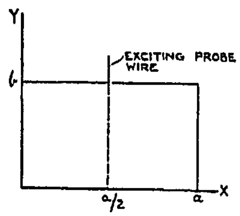

FIG. 1

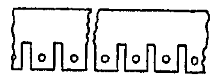

FIG. 3

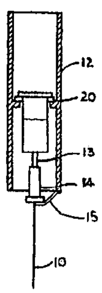

FIG. 4

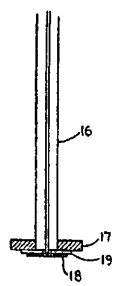

FIG. 5

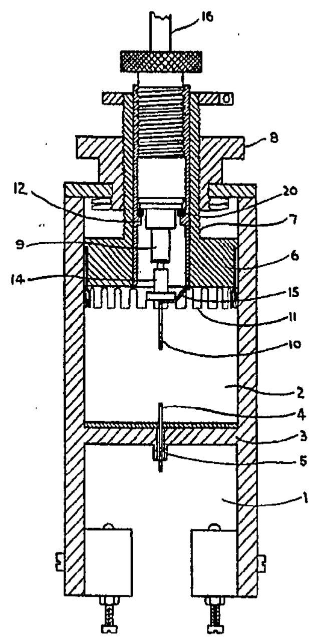

FIG. 2.